CLAIMS

1. A cooling device for dissipating heat to the surrounding air from at least one heat-generating component, the cooling device comprising:

at least one heat-sink having a pre-defined surface area, and having a plurality of heat-conducting elements arranged in a low-profile configuration, each of said elements provided with a plurality of air passages and having large surface-to-air contact area with the surrounding air, said large contact area being defined by a ratio between air-passage-areas formed in said elements and said pre-defined surface area;

wherein said elements are in thermal contact with the at least one heat-generating component so as to facilitate thermal flow from said at least one heat-generating component to said elements and to the surrounding air; and

wherein said heat-sink is adapted to operate with air-moving means to provide minimal thermal-flow resistance from said elements in thermal contact with said at least one heat-generating component to the air, per specific volume occupied by the cooling device.

2. The cooling device of claim 1 wherein said plurality of heat-conducting elements are selected from at least one of the group: perforated plate fins, indented plate fins, meshed wire-grid fins, pin fins, extruded perforated tubing sections, perforated solid block, plate fins thermally fused into a block, and any combination thereof.

3. The cooling device of claim 2 wherein said perforated plate fins, said indented plate fins, said meshed wire grid fins, said pin fins, and said extruded perforated tubing sections comprise discrete elements arranged in structures selected from the types: spaced-apart and tightly-stacked.

4. The cooling device of claim 2 wherein said perforated plate fins and said indented plate fins comprise elements arranged in continuously folded structures selected from the types: spaced-apart and tightly-stacked.

5. The cooling device of claim 2 wherein said perforated plate fins are populated by a plurality of air flow-through perforations and by a plurality of bordering heat-conducting bars.

6. The cooling device of claim 5 wherein said plurality of air flow-through perforations are provided in such manner that the footprint-area of the largest of said footprints of said perforations is smaller than 12 mm^2.

7. The cooling device of claim 6 wherein said footprint-area of said plurality of perforations populating a discrete heat-conducting element is cumulatively larger than 30% of the footprint-area of said discrete heat-conducting element.

8. The cooling device of claim 6 wherein said footprint-area of each of said plurality of perforations is smaller than half the area of the walls of each of said perforations.

9. The cooling device of claim 2 wherein said indented plate fins are populated by a plurality of indentations.

10. The cooling device of claim 9 wherein said plurality of indentations comprises protrusions enabling airflow at least over the face surface of said elements and the walls formed from said indentations.

11. The cooling device of claim 2 wherein said meshed wire-grid fins comprise at least a portion of said plurality of heat-conducting elements, said wire-grid fins thermally and mechanically connected to a pin fins base adapted to become thermally connected to said at least one heat-generating component.

12. The cooling device of claim 1 wherein said plurality of heat-conducting elements are composed of materials having at least two different heat-conducting coefficients; each of said elements grouped and arranged in order of their heat-conducting properties, a first group of elements with the highest heat-conducting coefficient disposed at the air outlet in said cooling device, whereas a second group with the lowest heat conducting coefficient is disposed at the air inlet to said cooling device, said groups of elements disposed in relative order of heat-conducting properties in relation to said first group and said second group.

13. The cooling device of claim 1 wherein said plurality of heat-conducting elements are discrete pin-fins, plate-fins and any combination thereof thermally attached to a solid, fins-supporting base.

14. The cooling device of claim 13 wherein said thermal contact between said at least one heat-generating component and said plurality of heat-conducting elements is via said fins-supporting base, said base being thermally-peripherally connected to said plurality of heat-

conducting-elements.

15. .The cooling device of claim 14 wherein said plurality of heat-conducting elements internally houses at least one portion of said air-moving means, said fins-supporting base being adapted to become eccentrically attached to said at least one heat-generating component.

16. The cooling device of claim 1 wherein said heat-conducting elements comprise walled-sections composed of flow-through, stacked perforated plates in thermal contact with said at least one heat-generating component in said heat-sink.

17. The cooling device of claim 16 wherein said thermal contact between said at least one heat-generating component and said plurality of heat-conducting elements is provided by at least one heat-conducting base, and said base and said walled-sections define a fin-free confined space bordered by the upper surface of said base and the internal surface of the walls facing said confined space and a fin-free opening providing fin-free air-contact between said confined space and the ambient air external thereto.

18. The cooling device of claim 1 wherein said heat-conducting elements comprise flow-through, stacked fins in thermal contact with said at least one heat-generating component in said heat-sink.

19. The cooling device of claim 18 wherein said thermal contact between said at least one heat-generating component and said stacked fins sections is provided by an annular-heat-conducting section whose internal space and walls are adapted to support and house at least a portion of said air-moving means adapted to become eccentrically attached to said heat-generating component.

20. The cooling device of claim 19 wherein said air-moving means comprises a motor.

21. The cooling device of claim 1 wherein said plurality of air passages comprise air-directing means for directing incoming airflow to enter directly into the openings defined by said footprint-area of inlet perforations in at least one of said face surfaces of said heat-conducting elements without impinging with the face surface surrounding said inlet perforations, said inlet perforations being oriented in the direction of said incoming airflow.

22. The cooling device of claim 1 wherein said plurality of air passages sustain a uniform mean-velocity vector of air flowing along the whole length of each individual passage of said plurality of air passages within said plurality of heat-conducting elements, prior to exhausting through-air from at least one air outlet in said heat-conducting elements.

23. The cooling device of claim 1 wherein said plurality of air passages in said plurality of heat-conducting elements are of uniform length.

24. The cooling device of claim 1 wherein said plurality of air passages, singularly and from each, in said plurality of heat-conducting elements are adapted to provide exhaust air at a uniform temperature from said heat-sink to the surrounding air.

25. The cooling device of claim 1 wherein said plurality of heat-conducting elements are at least isothermal in respect to the external periphery thereof.

26. The cooling device of claim 1 wherein said heat-sink further comprises a thermal-flow reduction means for reducing the thermal-flow resistance of said heat-sink with at least no increase in the overall weight of said cooling device.

27. The cooling device as claimed in claim 1 wherein said plurality of heat-conducting elements are provided with an equalizing means for equalizing the length of all thermal paths through heat-conducting sections of said heat-conducting elements, from the hottest edge to the coldest edge, when said sections are thermally connected to said at least one heat-generating-component.

28. The cooling device of claim 1 wherein said thermal contact between said at least one heat-generating component and said plurality of heat-conducting elements is selected from at least one of the following: indirect contact, direct physical contact, and any combination thereof.

29. The cooling device of claim 28 where said indirect contact comprises a thermal connection and any extension thereof, employing at least one of the following heat-conducting means: heat pipe, pin fins thermally protruding from a base, thermally fused sections of stacked

said heat-conducting elements, non-perforated section of a solid perforated block, external envelope attached to at least a section of the periphery of said heat-conducting elements, solid monolithic block, hollow monolithic block, solid multi-material block, hollow multi-material block, and annular section adapted to internally support the motor of an air-moving device.

30. The cooling device of claim 1 wherein said air-moving means comprises at least one motorized air-moving device attached to said heat-sink at any relative position in respect to the air inlets and air outlets of said plurality of heat-conducting elements and attached by any attachment means, said air-moving device comprising:

at least one motor for operating said air-moving device;

at least one motor-related impeller connected by a hub to said at least one motor; and

a plurality of impeller-supported blades for moving air;

said air-moving device generating airflow in contact with the air-exposed surfaces of said plurality of heat-conducting elements when said at least one motor rotates said impeller and blades.

31. The cooling device of claim 30 wherein said at least one motor, said motor-related impeller and said plurality of impeller-supported blades are disposed in any combination of relative positions in respect of each to the other, and in any combination of relative positions in respect to said walls and to open and closed spaces defined by the disposition of said heat-conducting elements within a particular heat-sink.

32. The cooling device of claim 30 wherein said motor-related impeller comprises a blades-free central section which is through-slotted by air passages providing impeller-through airflow in thermal contact with the air-exposed surface of said heat-conducting elements, when said impeller is rotating.

33. The cooling device of claim 30 wherein said at least one motorized air-moving device comprises at least one fan with at least one portion of said at least one motor embedded inside said plurality of heat-conducting elements providing said thermal contact between said at least one heat-generating component and said plurality of elements.

34. The cooling device of claim 33 wherein said at least one fan is provided with a plurality of blades disposed outside the area occupied by said heat-conducting elements, with the

footprint of said blades, including any peripheral section thereof, externally surrounding the area occupied by said elements, said footprint being at a radial distance enabling provision of higher air pressure for the same contact area between said elements with said at least one heat-generating component, without excessively increasing the rotating speed of said fan and the associated noise.

35. The cooling device of claim 1 wherein air-directing means changes at least the direction of the air-velocity vector for the airflow inhaled into said plurality of heat-conducting elements of said cooling device and the airflow exhaled out of said elements.

36. The cooling device of claim 1 wherein said air-directing means maintains the uniformity of at least the magnitude of the air-velocity vector for the airflow inhaled into said plurality of heat-conducting elements of said cooling device and the airflow exhaled out of said elements.

37. The cooling device of claim 1 wherein said air-directing means adjusts the volumetric proportions of the airflow inhaled into said heat-conducting elements per unit of time and the volumetric airflow exhaled simultaneously out of said heat-conducting elements per same unit of time, at any combination and proportions thereof.

38. The cooling device of claim 1 wherein said air-directing means changes the direction and magnitude of the air-velocity vector for the airflow inhaled into the section occupied by said air-moving means of said cooling device and the airflow exhaled out of said section.

39. The cooling device of claim 1 wherein said air-directing means keeps uniform at least the magnitude of the air-velocity vector for the airflow inhaled into the section occupied by said air-moving means of said cooling device and the airflow exhaled out of said section.

40. The cooling device of claim 1 wherein said air-directing means adjusts the volumetric proportions of the airflow inhaled through the section occupied by said air-moving means per unit of time and the volumetric airflow exhaled simultaneously through said section per same unit of time.

41. The cooling device of claim 1 wherein said low-profile arrangement of said plurality of heat-conducting elements is characterized by minimal axial thickness and low axial height of said elements when disposed in said thermal contact with and in close proximity to said at least one heat-generating component, and wherein said elements and said at least one heat-generating component are disposed relative to one another on a mounting surface so as to minimize the distance between adjacent, parallel mounting surfaces.

42. The cooling device of claim 1 wherein said heat-sink is reduced in the weight of constituent components without substantially affecting the thermal resistance of said heat-sink.

43. The cooling device of claim 1 further comprising a removable air filter mounted on the air inlet to said heat-conducting elements.

44. The cooling device substantially as described herein by way of example and with reference to the drawings.

45. A method for cooling at least one heat-generating component mounted on a mounting surface, said method comprising:

providing at least one heat-sink having a pre-defined surface area, and having a plurality of heat-conducting elements arranged in a low-profile configuration, each of said elements provided with a plurality of air passages and having large surface-to-air contact area with the surrounding air, said large contact area being defined by a ratio between air-passage-areas formed in said elements and said pre-defined surface area; wherein said elements are in thermal contact with the at least one heat-generating component so as to facilitate thermal flow from said at least one heat-generating component to said elements and to the surrounding air; and

operating an air-moving means together with said heat-sink to provide minimal thermal-flow resistance from said elements in thermal contact with said at least one heat-generating component to the air, per specific volume occupied by the cooling device.

46. The method of operation of a cooling device substantially as described herein by way of example and with reference to the drawings.